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Time of spawning in Subdivision 3Ps cod (*Gadus morhua*)

Période de fraie de la morue dans la subdivision 3Ps (*Gadus morhua*)

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ABSTRACT

This study examined data from the DFO ecosystem survey of Subdiv. 3Ps to determine if there has been a change in spawning time that might make the fisheries management closure for spawning unsuitable. Data from 1972 to 2009 were analysed for the offshore and inshore strata of the survey separately. In addition the proportion of female fish in various maturity stages in April was calculated for inshore and offshore strata separately. The data do not show any trends that would indicate a shift in spawning time. The current spawning closure in the offshore appears to encompass most of the spawning period. Spawning time could not be estimated from the inshore but previous studies have found spawning fish from March to August.

RÉSUMÉ

Cette étude analyse les données du relevé sur l'écosystème de la subdivision 3Ps de MPO pour établir s'il y a eu des changements dans la période de fraie; lesquels seraient susceptibles de mettre fin à la gestion des pêches suite à une fraie inappropriée. Les données pour la période de 1972 à 2009 quant aux strates hautières et côtières du relevé ont fait l'objet d'une analyse distincte. De plus, la proportion de poissons femelles au cours de différents stades de maturité, en avril, a été calculée de façon distincte dans le cas des strates hautières et côtières. Les données ne montrent aucune tendance suggérant un changement dans la période de fraie. La fermeture actuelle de la fraie marine englobe, semble-t-il, la plus grande partie de la période de fraie. Cette dernière ne peut faire l'objet d'une évaluation du point de vue côtier, mais des études antérieures ont répertorié des poissons frayants du mois de mars au mois d'août.

INTRODUCTION

This study addresses the following ToR for the assessment of 3Ps cod in September 2009: 'There is currently a spawning period from April 1 to June 30 for the offshore and April 1-May 30 for the inshore. Since some fleets have requested to fish cod during these times, are these spawning times still accurate? What is the impact of cod removals in the range of 500 t in March and April?

This ToR refers to the spawning closure periods. Only the timing of spawning will be addressed in this study not the impact of removing 500 t during spawning. The spawning closure in the offshore actually begins on March 1.

There have been previous studies on the time of spawning of cod in Subdiv. 3Ps. Interannual variation in spawning time has been reported for the offshore (Hutchings and Myers 1994). Spawning time in this region, assessed as the day at which 50% of fish are spent, has been found to vary from about day 90 to about day 170 with a very broad spawning season (Hutchings and Myers 1994; Myers et al. 1993). Using all data combined from 1947 to 1991 Myers et al. (1993) estimated that day 141 (April 21) was the mean day at which 50% of the fish were spent.

Inshore studies have also found a very broad spawning season with spawning fish being present from March to August (Bolon and Schneider 1999; Rideout 1999). There also appears to be variation between years in spawning time in the inshore with peak spawner density occurring in April in 1997 and June in 1998 (Lawson and Rose 1999).

This study provides analyses of the time of spawning of cod in 3Ps using data from the DFO ecosystem survey from 1972 to 2009.

METHODS

Annual spawning times were modelled using generalised linear models with logit link function and binomial error to determine the proportion of fish spent on each day, and to determine the day of the year on which 50% of the fish were spent. Only adult females were included. Fish were classed according to maturity staging of Templeman et al. (1978). Fish that were ripening, spawning (including partly spent), or skipping spawning were classed as not spent (if 520 less than or equal maturity less than or equal 550 or 650 less than or equal maturity less than or equal 652 then spent=0) and fish that were spent or spent and ripening for next year (if 560 less than or equal maturity less than 580 then spent=1) were classed as spent. Day was included as a continuous variable and year as a class variable. Only years with a significant day effect when modelled by year were included to test for a significant year effect. Data for the offshore and inshore strata of the survey were modelled separately. The inshore strata are as defined in Brattey et al. (2008).

In addition the proportion of female fish in various maturity stages in April was calculated for inshore and offshore strata separately. Fish with maturity=520 or 650 less than or equal maturity less than or equal 652 were considered ripening, with 530 le maturity le 550 were considered to be spawning, 560 less than or equal maturity less than or equal 562 were classed as spent and all other adult females were placed in an 'other' category.

RESULTS AND DISCUSSION

There was no significant fit of the model to the data in any year for the inshore strata alone. For the offshore strata there was a significant model fit in 8 years. D50 varied from day 82 (March) to day 154 (June). There was significant variation among years (χ^2=1120, df=7, p<0.0001). However, there is no evidence of a trend in D50 (Fig. 1 and 2).

If one defines the length of the spawning season as the period between 20% of the fish being spent and 80% being spent then the spawning season in 3Ps ranged from 8 to 38 days (Fig. 2). The estimate of 8 days for 1977 is unrealistic since the spawning period of a single female cod is usually about a month (Kjesbu 1989) and all of the durations may in fact be underestimates. Also by estimating the time at which 50% of the fish are spent the D50 is actually later than the peak of spawning in each year. In all years the estimated spawning period is finished before June 30. The latest estimated day at which 80% of the fish are spent is June 10 in 1982.

Both the estimate of D50 and the length of time of spawning are likely affected to some extent by timing of the survey relative to spawning time. For example in some years the survey occurred before any spawning had taken place and so there is no fit of the model to the data in those years. Other factors like the short survey period and spatial and temporal variation in spawning time within the subdivision, can also have some impact on the estimates.

The proportion of fish in different maturity stages in April shows substantial variability from year to year in both the inshore and offshore strata (Fig. 3). However, there is no indication of a trend that could indicate a change in spawning time.

In conclusion, the data from the DFO survey do not show any trends that would indicate a shift in spawning time. In all years for which estimates could be produced in the offshore spawning was completed before June 30. The spawning closure in the offshore (March 1–June 30) covers the majority of the spawning period there. No new estimates were possible for the inshore but previous studies have found spawning fish into August.

ACKNOWLEDGMENTS

This paper is only possible because of the work of many people in the collection of these data. This work is an extension of work of the NAFO WG on reproductive potential.

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Table 1. Parameter estimates from generalize linear models of the effect of day on the proportion of females spent. D50 is the estimated day at which 50% of the fish are spent. Only years with significant model fit are shown.

Year	Offshore strata Intercept	Slope	d50	Month
1977	-42.69	0.3774	113	April
1982	-29.35	0.1912	154	June
1983	-16.09	0.1216	132	May
1987	-8.97	0.1088	82	March
1993	-15.79	0.1334	118	April
1999	-9.31	0.0712	131	May
2003	-22.14	0.1889	117	April
2005	-21.29	0.1644	130	May

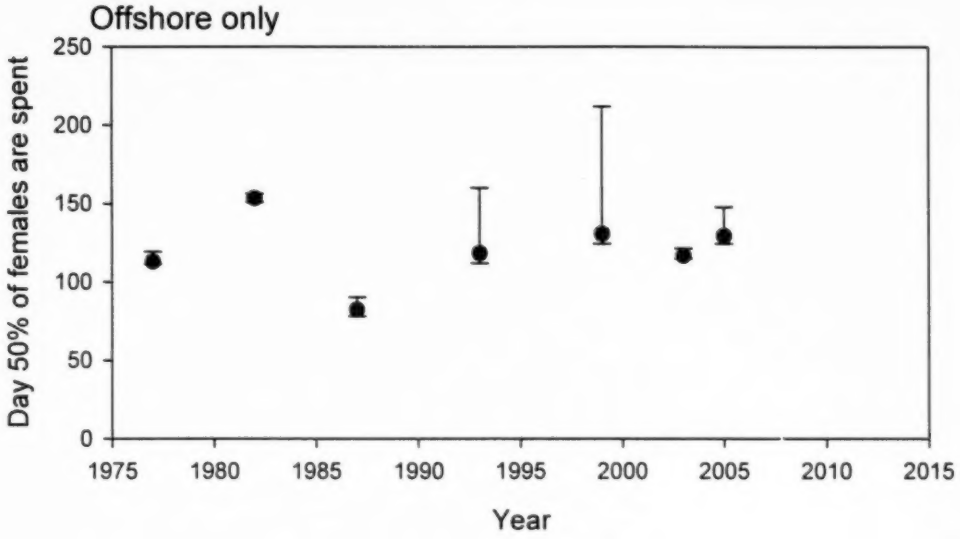

Figure 1. Day at which 50% (± 95% fiducial limits) of females are estimated to be spent for Subdivision 3Ps cod in the offshore strata of the annual bottom trawl survey conducted by DFO.

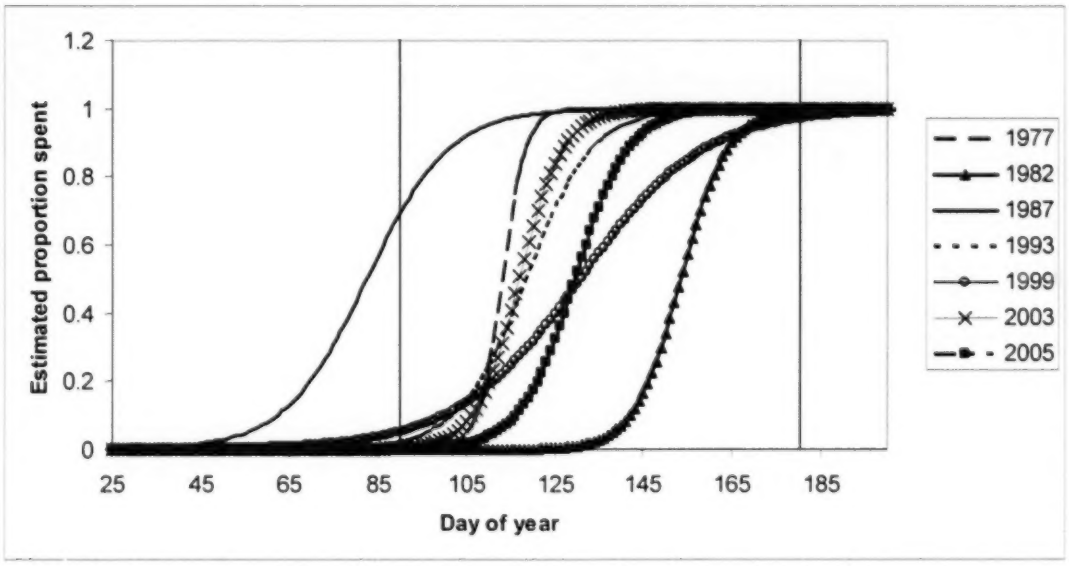

Figure 2. Estimated proportion spent for female cod in Subdivision 3Ps from the offshore strata of the annual bottom trawl survey conducted by DFO. Note that the curve for 1999 is covered by the one for 2003.

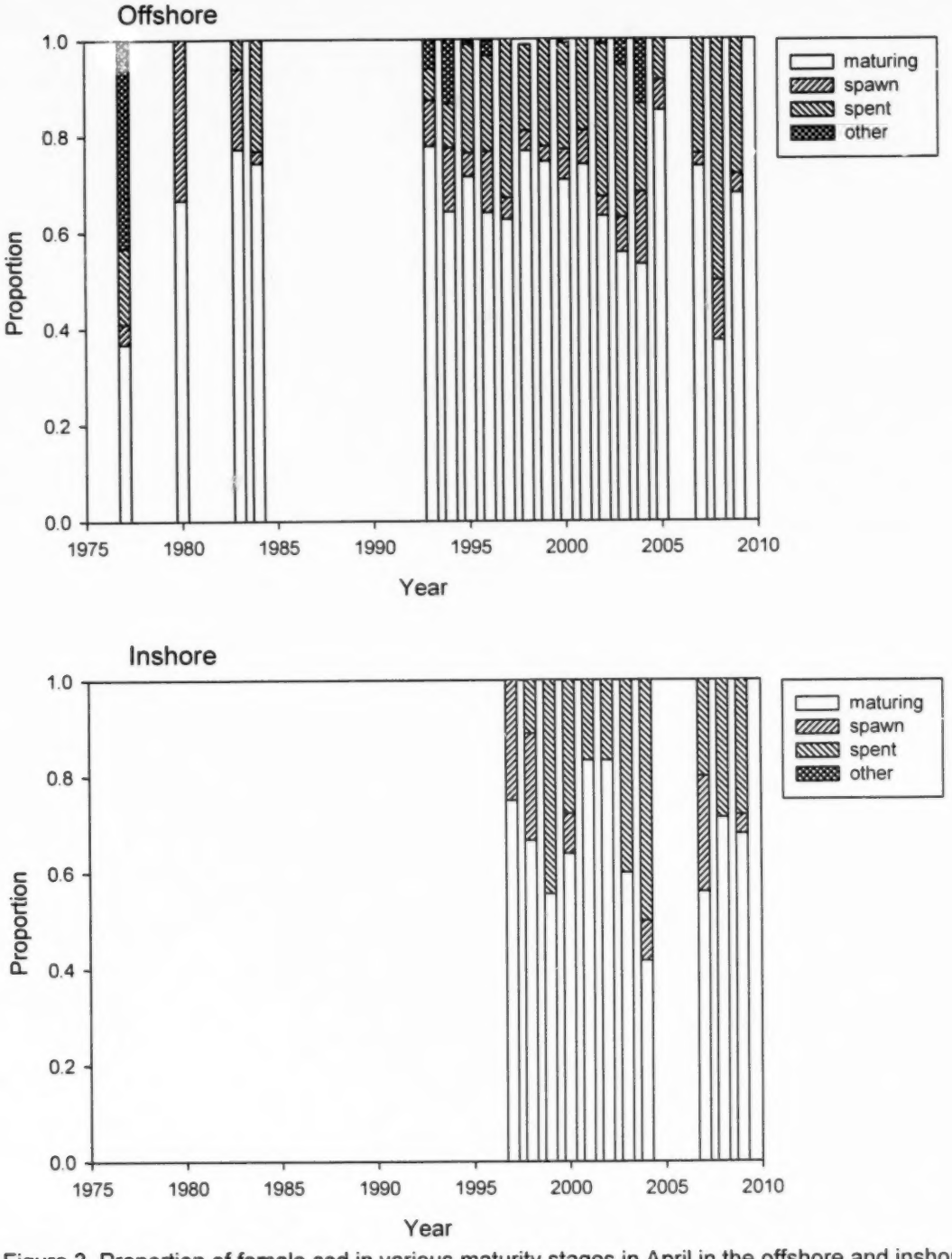

Figure 3. Proportion of female cod in various maturity stages in April in the offshore and inshore strata of the annual DFO bottom trawl survey. The survey was incomplete in the entire area in 2006 and in the inshore in 2005 no adult fish were sampled in April.